

# Boston Digital™ Arm



Liberating Technologies **Boston Digital™ Arm System** is a microcomputer-based prosthesis using state of the art components. It is actually a control “platform” for various upper-limb prosthetic devices such as hands, grippers, wrist rotators, and even shoulder lock actuators. It can control up to five devices and is compatible with all manufacturers’ prosthetic components including the latest dexterous hands, bebionic and iLimb. This system accepts input signals from a variety of sensors including; myoelectrodes, positional servo transducers, force-sensing resistors (Touch Pads), and switches. Myoelectrodes are often preferred because they sense the users muscle signals from the surface of the skin and use these signals to proportionally control the prostheses. This allows the user to control the direction, speed, strength and even select the prosthetic device being operated. Other sensors can be used in conjunction with myoelectrodes to meet the specific needs of the user.

In many instances, it is beneficial to use multiple inputs allowing the user to control various prosthetic devices independently. This enables the user to control these devices simultaneously for more efficient and natural movement. The **Boston Digital Arm** supports simultaneous control of up to five prosthetic devices. This feature has made the Arm popular among clinicians who fit users who have undergone Targeted Muscle Reinnervation surgery (TMR). As a result of the surgery, these users have more muscle sites than normal, thus allowing them to take full advantage of the systems ability to simultaneously control multiple devices.

Control strategies are stored in software and downloaded from a personal computer to the prosthesis. Many popular control strategies have been developed and are available to the clinician. Client-specific adjustments are made through this software enabling the prosthetist to customize the control for the user. Critical settings like myoelectrode gains and thresholds are made with the aid of graphical displays.

**LTI** Liberating Technologies, Inc.

325 Hopping Brook Road, Holliston, MA 01746

<http://www.liberatingtechnologies.com>

508-893-6363, Fax 508-893-9966

In 2010 the **Boston Digital™ Arm System** was upgraded with several significant improvements. The drive mechanism is a refinement of a design that has served users well for more than 20 years. Due to its durability, high torque and precise speed capabilities, this design is still preferred. Recent improvements include bearing and gear changes resulting in smoother, quieter performance. The system was originally designed (by Liberty Mutual Insurance Company) to help get injured people back to work and is still the Arm of choice for people who intend to perform personal or work-related tasks requiring reasonable strength. The Boston Elbow has a long history of successful rehabilitation and has helped many people regain their independence and in some cases return to work. This version of the Boston Digital™ Arm will carry this tradition forward employing leading-edge technology to further enhance the lives of people with disabilities.

The forearm and battery covers are now molded from high-strength urethane for a better finish and greater durability. These can be ordered in several colors. The battery has also been upgraded to a high-capacity version for improved performance and longevity. The high energy-density of lithium chemistry provides twice the capacity of older batteries and yet a significant weight reduction. Lithium has excellent performance characteristics with no undesirable “memory” like Ni-CAD batteries.

This new lithium-polymer battery (BE360) has a capacity of 2,000 mAh, twice the capacity of the original battery allowing it to operate all day on a single charge regardless of the components used. The new battery also has an on-board fuel gauge which indicates the state of charge and a safety circuit to assure safe and reliable operation.



New Lithium-polymer Battery

At 172 grams this new battery is 30% lighter than the previous battery. It reduces the total weight of the Boston Digital Arm to less than 2 pounds!

Because of the demand for humeral-level prostheses using the new multi-articulating hands (*bebionic* or *iLimb*) with a powered elbow, the new Boston Arm Lithium-polymer battery has been designed with an optional circuit board specifically for these multi-motor terminal devices. This circuit (BE361) regulates the battery voltage to 7.4 volts for these hands and delivers the current (up to 6 amps) required for this new class of terminal device to operate effectively.

The new Lithium-polymer battery is backward compatible and can be fit to older Boston Digital Arm Systems, so when a patient's Ni-CAD battery reaches 2-4 years of age, this battery is an excellent choice as a replacement. Additionally, if a patient wants to change to one of the new multi-articulating hands (*bebionic* or *iLimb*), the battery upgrade can be done at the same time to optimize the hand's performance.

# Boston Digital™ Arm Features

## Retained Features:

- Enhanced reliable drive mechanism and motor as Original Boston Elbow
- automatic locking, power to unlock, can be unlocked under load
- high strength/torque (10 ft-lbs)
- fast, completes a full cycle in 1.2 sec
- free swing 45° (mechanical)
- compatible with all manufactures hands & wrists, including the new multi-articulating hands

## New Features:

- approved for CE mark
- new high-capacity battery, 2000 mAHr Lithium-polymer
- lighter weight – now under 2 pounds!
- high-sensitivity myoelectric signal processing
- differential, first-come-first-served or maximum myoelectric control
- adjustable offset/deadband to eliminate unwanted noise from myoelectric signals
- independent gains for each channel/muscle
- reliable Surface Mount Technology (SMT) fabrication method
- uses Texas Instruments Digital Signal Processor
- up to five motor control
- simultaneous operation of two devices
- independent controls (i.e. elbow may be controlled by proportional positional servo or linear transducer while terminal device is controlled by myoelectric signals)
- motor current feedback for enhanced performance
- optional audible or vibratory feedback to confirm mode selection/switching
- removable battery in color-matched case with on/off switch and recharge connector
- on-board recharging capability and state-of-charge indicator
- accommodates two myoelectric and six other analog inputs
- accommodates single-site control
- automatically shifts from proportional velocity to proportional grip control
- revert feature allows control to revert to the default mode after a settable interval

## Computer Interface:

- patient evaluation mode
  - optimizing differential control
  - selecting the best control strategy
- several clinically-relevant control strategies are available
- strategies are pre-loaded, but clinician may make changes locally
- motor controls can be set to limit maximum current to the device manufacturer's limit